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IS 4454-4 (2001): Steel Wires for Mechanical Springs, Part 4: Stainless Steel Wire [MTD 4: Wrought Steel Products]

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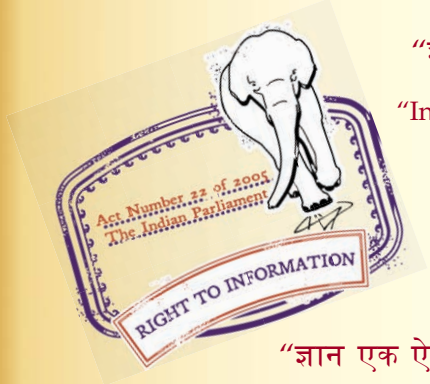

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(दूसरा पुनरीक्षण)

Indian Standard

STEEL WIRE FOR MECHANICAL SPRINGS – SPECIFICATION

PART 4 STAINLESS STEEL WIRE

(Second Revision)

First Reprint JANUARY 2005
(Including Amendment No. 1)

ICS 21.160; 77.140.25

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

March 2001

Price Group 4

FOREWORD

This Indian Standard (Part 4) (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Wrought Steel Products Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1967 and subsequently revised in 1975. While reviewing the standard in the light of experience gained during these years, the Committee decided to revise it to bring it in line with the present practices being followed by the Indian industry.

In this revision following changes have been made:

a) Grades of steel have been increased to three.

b) Chemical composition and tensile strength values have been modified.

c) Dimensional tolerances have been modified.

d) Provision of cast of the wire, bend test and coiling test have been included.

An informative Annex A has been given for the benefit of purchaser giving particulars to be specified by the purchaser while placing order for the spring wires covered in this standard.

The properties governing the application of steels for springs may be considerably influenced by their chemical composition as well as the modes of mechanical treatment and heat treatment applied. It is for these reasons that a very large variety of steels may be employed in the manufacture of steel springs. This variety is further increased owing to the fact that in certain cases these springs have to exhibit considerable resistance against corrosive influences and withstand elevated temperature and that the mechanical stress is imposed on them vary considerably. In order to facilitate clear survey, the steels are classified into three categories.

This part is one of the series of Indian Standards on steel wire for mechanical springs. Other parts in the series are:

Part 1 Cold drawn unalloyed steel wire, and

Part 2 Oil hardened and tempered steel wire.

Examples of application for stainless spring steel wire have been given in Annex B.

In this revision, necessary assistance has been derived from

a) ISO 6931-1 : 1989 Stainless steel for springs : Part 1 Wire

b) ISO/CD 8458-1 Steel wire for mechanical springs : Part 1 General requirements (August 1998)

c) prEN 10270-3 Steel wire for mechanical springs : Part 3 Stainless spring steel wire (June 1996)

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

AMENDMENT NO. 1 MAY 2002
TO
IS 4454 (PART 4) : 2001 STEEL WIRES FOR MECHANICAL SPRINGS – SPECIFICATION

PART 4 STAINLESS STEEL WIRE

(Second Revision)

(*Page* 6, *Table* 5) — Substitute the following table for the existing:

Table 5 Reference Data for the Modulus of Elasticity and Rigidity

Steel Grade	Modulus of Elasticity MPa		Modulus of Rigidity MPa	
	Untempered	Tempered	Untempered	Tempered
(1)	(2)	(3)	(4)	(5)
1	185 000	195 000	70 000	73 000
2	185 000	195 000	70 000	73 000
3	1 80 000	190 000	68 000	71 000

(MTD 4)

Printed at New India Printing Press, Khurja, India

Indian Standard

STEEL WIRE FOR MECHANICAL SPRINGS — SPECIFICATION

PART 4 STAINLESS STEEL WIRE

(Second Revision)

1 SCOPE

1.1 This standard (Part 4) covers stainless steels listed in Table 1 which are usually used in the cold drawn condition in the form of wire of circular cross-section up to 10 mm in diameter, for the manufacture of springs and spring parts that are exposed to corrosive effects and sometimes to slightly increased temperatures.

1.2 Stainless steels which are covered in this standard and which exhibit special corrosion resistance are of austenitic type with chromium contents higher than 12 percent and are spring hard cold drawn.

NOTE — Many steels other than those mentioned in Table 1 exist for use against special kinds of corrosion attacks but the requirements for springs in such conditions are not large.

2 REFERENCES

The following Indian Standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
228 (in Parts)	Method for chemical analysis of steel
1608 : 1995	Mechanical testing of metals-tensile testing (*second revision*)
1755 : 1983	Method for wrapping test for metallic wire (*first revision*)
1956 (Part 5) : 1976	Glossary of terms relating to iron and steel : Part 5 Bright steel bar and steel wire (*first revision*)
4905 : 1968	Methods for random sampling
8910 : 1978	General technical delivery requirements for steel and steel products
12261 : 1987	Method for reverse torsion test for metallic wire

3 TERMINOLOGY

3.1 For the purpose of this standard, the definitions given in IS 1956 (Part 5) and the following shall apply.

3.2 Cast; Helix; Pitch

The way in which a single ring of wire behaves when cut from coil.

NOTES

1 Well-cast wire will lie flat on itself in uniform circles. Spiral cast denotes the tendency of the rings out from the coil in spirals. Straight cast wire runs out approximately straight when unwound from the coil

2 The terms spool, spoolless core and cheese are synonymous with coil.

3.3 Static Duty

Qualifies applications where springs are subjected to static stresses or infrequent dynamic loading, or a combination of both.

NOTE — This does not apply to situations of low frequency high stress.

3.4 Dynamic Duty

Qualifies applications where springs are subjected to frequent or predominantly dynamic loading and where small coiling ratios or severe bending radius is required.

3.5 Ring

One turn of wire from a coil, that is, one complete circle of wire.

NOTE — A ring of wire does not imply any specific length of wire or diameter of wire.

4 SUPPLY OF MATERIAL

General requirements relating to the supply of material shall be as laid down in IS 8910.

5 GRADES

The stainless steel wire shall be of three grades designated as Grade 1, Grade 2 and Grade 3 respectively.

6 MANUFACTURE

The processes used in making the steel and in

manufacturing stainless spring steel wire are left to the discretion of the manufacturer. The purchaser shall be informed of the manufacturing process, if he so desires.

7 CHEMICAL COMPOSITION

7.1 Ladle analysis of the material when carried out either by the method specified in the relevant part of IS 228 or any other established instrumental/chemical method, shall be as given in Table 1. In case of dispute, the procedure given in the relevant part of IS 228 shall be the referee method. However, where the method is not given in IS 228 or its relevant parts, the referee method shall be as agreed to between the purchaser and the manufacturer.

7.2 Product Analysis

Permissible variations in case of product analysis from the limits specified in Table 1 shall be as given in Table 2.

8 FREEDOM FROM DEFECTS

The surface of the wire shall be smooth and as free as possible from defects, such as grooves, pits, die-marks, and other harmful defects, which have a noticeable adverse effect on the application of the wire.

9 DIMENSIONS AND TOLERANCES

9.1 Tolerance on diameter of wire shall be as specified in Table 3.

9.2 The difference between the maximum and minimum diameter of the wire at the same cross-section shall not be more than 50 percent of the total permissible deviation specified in Table 3.

9.3 The length tolerance for the wires in cut length shall be plus 0.01 × nominal length in mm and minus zero.

9.4 The straightness of cut length wires shall be

Table 1 Chemical Composition

(*Clauses* 1.1, 1.2, 7.1 *and* 7.2)

Grade	Designation	Constituent, Percent							
		C *Max*	Si *Max*	Mn *Max*	S *Max*	P *Max*	Cr	Ni	Mo
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	X07Cr18Ni9	0.15	1.00	2.00	0.030	0.045	17.0 to 19.0	8.0 to 10.0	—
2	X04Cr19Ni9	0.08	1.00	2.00	0.030	0.045	17.0 to 20.0	8.0 to 10.0	—
3	X04Cr17Ni12Mo2	0.08	1.00	2.00	0.030	0.045	16.0 to 18.0	10.0 to 14.0	2.0 to 3.0

NOTE — Alternate composition may be used by agreement.

Table 2 Permissible Variations for Product Analysis

(*Clause* 7.2)

Constituent	Permissible Variations Over and Under Specified Limit Percent, *Max*
(1)	(2)
Carbon	0.01
Manganese	0.03
Silicon	0.05
Sulphur	0.005
Phosphorus	0.005
Chromium	0.20
Nickel	0.10
Molybdenum	0.10

0.5 mm for 500 mm length for diameter up to 6 mm. For diameter above 6 mm, the straightness shall be 2 mm for 1 000 mm.

9.5 Tolerance other than these specified in Table 3 may be mutually agreed to between the purchaser and the manufacturer.

10 MECHANICAL PROPERTIES

10.1 Tensile Test

10.1.1 The tensile test when carried out in accordance with IS 1608, the tensile strength shall be as given in Table 4.

10.1.2 These values are valid for round section wire in bright, and cold drawn condition. The tensile strength shall be calculated based on the original cross-section of wire.

10.1.3 The deviation in tensile strength within a coil shall not exceed the following but the tensile values fall within the specified limit.

a) 100 MPa for wires of diameter less than or equal to 1.50 mm; and

b) 70 MPa for wires of diameter over 1.50 mm and up to and including 10.00 mm.

10.2 Wrapping Test

The wrapping test shall be applied to wires with a diameter of 0.30 up to 3.00 mm and shall be carried out in accordance with IS 1755. The wire shall not show any sign of fracture when close wrapped eight turns around a mandrel of diameter equal to that of the wire.

10.3 Reverse Torsion Test

10.3.1 The reverse torsion test shall be applied to wires with nominal diameter up to and including 10 mm, if agreed to between the purchaser and the manufacturer.

10.3.2 The reverse torsion test shall be carried out in accordance with IS 12261.

10.3.3 The test piece shall withstand, without failure, first two complete turns in one direction and then two turns back in the other direction on a gauge length equivalent to $100 \times d$ (d = nominal diameter of the wire) with a maximum of 300 mm.

10.3.4 No crack or any other surface defects shall be present on the surface of wire.

10.4 Cast of the Wire

The wire shall be uniformly cast. When a ring of wire is cut from the package and allowed to fall on the surface,

Table 3 Diameter Tolerances

(*Clauses* 9.1, 9.2 *and* 9.5)

Nominal Diameter of Wire, mm		Diameter Tolerance, mm		
		Coil	Cut Length	
Over	Up to and Including		Plus	Minus
(1)	(2)	(3)	(4)	(5)
—	0.20	± 0.005	0.005	0.009
0.20	0.25	± 0.005	0.005	0.009
0.25	0.40	± 0.008	0.008	0.018
0.40	0.65	± 0.008	0.008	0.018
0.65	0.80	± 0.010	0.010	0.025
0.80	1.00	± 0.010	0.010	0.025
1.00	1.60	± 0.015	0.015	0.040
1.60	2.25	± 0.015	0.015	0.050
2.25	3.20	± 0.020	0.020	0.070
3.20	4.00	± 0.020	0.020	0.080
4.00	4.50	± 0.025	0.025	0.100
4.50	6.00	± 0.025	0.025	0.120
6.00	6.25	± 0.025	0.025	0.020
6.25	7.00	± 0.030	0.030	0.135
7.00	9.00	± 0.030	0.030	0.160
9.00	10.00	± 0.035	0.035	0.185

Table 4 Tensile Strength for Stainless Steel Spring Wire

(*Clause* 10.1.1)

Wire Diameter (Nominal), mm		Tensile Strength for Grades, MPa, *Min*			Reduction of Area after Fracture Percentage, *Min*
Over	Up to and Including	Grade 1	Grade 2	Grade 3	
(1)	(2)	(3)	(4)	(5)	(6)
—	0.20	2200	2350	1720	—
0.20	0.30	2150	2300	1700	—
0.30	0.40	2150	2250	1670	—
0.40	0.50	2050	2200	1650	—
0.50	0.65	2000	2150	1620	—
0.65	0.80	1950	2100	1600	—
0.80	1.00	1900	2050	1570	—
1.00	1.25	1850	2000	1550	40
1.25	1.50	1800	1950	1500	40
1.50	1.75	1750	1900	1450	40
1.75	2.00	1700	1850	1400	40
2.00	2.50	1650	1750	1350	40
2.50	3.00	1600	1700	1300	40
3.00	3.50	1550	1650	1250	40
3.50	4.25	1500	1600	1225	40
4.25	5.00	1450	1550	1200	40
5.00	6.00	1400	1500	1150	40
6.00	7.00	1350	1450	1125	40
7.00	8.50	1300	1400	1075	40
8.50	10.00	1250	1350	1050	40

NOTES

1 1 MPa = 1 N/mm² = 1 MN/m² = 0.102 0 kgf/mm².

2 The maximum tensile strength shall be the minimum value plus 15 percent of the minimum value.

3 The wire is supplied in cold drawn condition. The tensile strength in the finished spring may be substantially influenced by a heat treatment.

the wire shall lie flat and not show a spiral cast.

10.4.1 By mutual agreement between the manufacturer and the purchaser, for sizes up to 5 mm, the cast requirements may be considered as being fulfilled if the following condition is satisfied:

An individual ring taken from the coil or bobbin and freely hung on a hook may show an axial displacement '*f*' at the ends of the ring (*see* Fig. 1). This displacement '*f*' shall not exceed a value given by the following inequality:

$$f \leq \frac{(0.2\ D)}{\sqrt[4]{d}}$$

where

D = Mean diameter of the individual ring measured when lying horizontal in mm; and

d = Nominal diameter of the wire in mm.

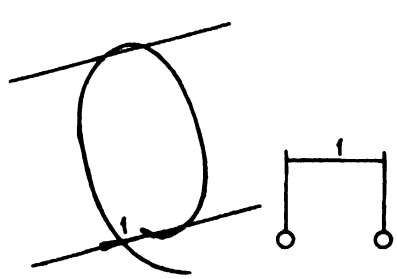

FIG. 1 CAST OF THE WIRE

10.5 Bend Test

The bend test may be applied to wires with nominal diameter greater than 3.00 mm diameter. The wires shall not show any sign of fracture when bent through an angle of 180° to form a U around a mandrel of diameter equal to twice the wire diameter for sizes above 3.00 mm to 6.00 mm and equal to three times the wire diameter for sizes above 6.00 mm.

10.6 Coiling Test

The coiling test may be applied to wires with a nominal diameter of 0.50 mm to 1.50 mm with mutual agreement between the purchaser and the manufacturer. A test piece approximately 500 mm in length is closely wound, under slight but reasonably uniform tension on a mandrel, three to three and half times the nominal wire diameter with a minimum of 1.00 mm. The closed coil is then stretched so that after releasing the stress, it sets to approximately three times its original length. The wire shall show a defect free surface condition without splits or fracture and the coil shall have a uniform pitch of the turns and a fair dimensional regularity of its diameter.

11 SURFACE FINISH

The wire may be coated or uncoated. The specific coating and finish for stainless steel spring wire for example uncoated, polished finish, nickel coated, etc, shall be mutually agreed to between the purchaser and the manufacturer.

12 SAMPLING

Unless otherwise agreed to, the method of drawing representative samples of the material and the criteria for conformity shall be as prescribed in Annex C.

13 CONDITION OF DELIVERY

13.1 The coil of wire shall consist of one single length of wire originating from one heat only and shall not have welds. The bundle of cut lengths of wire shall consists of wire originating from one heat only. The wires shall not be kinked and wavy.

13.2 The wire may be supplied in coated or uncoated condition as per mutual agreement between the purchaser and the manufacturer.

13.3 The mass of the coils/bundles, the eye dimensions and other forms of supply shall be mutually agreed to between the purchaser and the manufacturer.

14 PACKING

The packing of the material shall be done in such a way that the material is suitably protected against mechanical damage and/or contamination during transit. The suitable mode of packing shall be mutually agreed to between the purchaser and the manufacturer.

15 MARKING

15.1 Each coil of wire and bundle of straightened and cut lengths shall be legibly marked with the following information:

a) Name of the supplier,
b) Wire grade,
c) Wire diameter,
d) Surface finish,
e) Mass of the coil/bundle,
f) Cast or batch number, and
g) Date of supply.

15.1.1 The material may also be marked with the Standard Mark.

15.1.2 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(*Foreword*)

INFORMATION TO BE GIVEN BY THE PURCHASER

A-1 BASIS FOR ORDER

While placing order for spring steel wires covered by this standard, the purchaser shall specify the following:

a) The desired quantity,
b) The wire grade,
c) Nominal wire diameter,
d) Surface finish and coating where relevant,
e) The form and condition of delivery,
f) Tests required,
g) Any special requirement, and
h) Test report.

ANNEX B

(*Foreword*)

EXAMPLES OF APPLICATION OF STAINLESS STEEL SPRING WIRE

B-1 GENERAL

At the time of choosing stainless steel spring wire, besides considering the mechanical conditions under which the spring has to function, the corrosive elements to be encountered shall also be taken into account. All the three grades withstand normal atmospheric as well as steam and other corrosive media. Since many other factors like working temperature and concentration of attacking medium also influence the corrosion resistance, the spring or wire manufacturer should be consulted in individual cases. All the three grades also withstand elevated temperatures not exceeding 300 °C. The permissible stress values for the dynamic working conditions should be required from the spring manufacturer since it depends especially in the case of these materials to a large extent on the chemical composition, mode of manufacture of the wire, surface conditions of wires, and so on. The fatigue limit may be considered as moderate compared to patented and hard drawn spring steels.

B-2 The three grades of steel have slightly different values for the modulus of elasticity, determined on longitudinal test pieces, and the shear modulus of rigidity and the values are given in Table 5 for guidance only.

It should be taken into account that with increasing temperature the values of the modulus of elasticity and the shear modulus decrease.

Table 5 Reference Data for the Modulus of Elasticity and Rigidity

(*Clause* B-2)

Steel Grade	Modulus of Elasticity MPa		Modulus of Rigidity MPa	
	Untempered	Tempered	Untempered	Tempered
(1)	(2)	(3)	(4)	(5)
1	19 500	18 500	73 000	70 000
2	19 500	18 500	73 000	70 000
3	19 000	18 000	71 000	68 000

ANNEX C

(*Clause* 12)

SAMPLING AND CRITERIA FOR CONFORMITY

C-1 LOT

In any consignment, all the coils of wire of the same grade and diameter manufactured under essentially similar conditions of manufacture shall be grouped together to constitute a lot.

C-1.1 Sample shall be taken from each lot and tested for conformity to the standard.

C-2 SAMPLING

The number of coils to be taken from a lot shall be according to col 1 and 2 of Table 6. These samples shall be taken at random by using random number tables (*see* IS 4905).

C-3 PREPARATION OF SAMPLES AND NUMBER OF TESTS

C-3.1 Tests for Physical Requirements

From the coils selected from col 1 and 2 of Table 6, adequate length of test piece shall be cut from each end and subjected to physical tests, namely, size, surface condition, tensile, bend, wrapping and coating tests. A test piece failing to meet any one of the requirements, shall be called a defective. If the number of defectives found is less than or equal to the permissible number of defectives specified in col 3 of Table 6, the lot shall be considered to have conformed to physical requirements.

C-3.2 Tests for Chemical Requirements

Unless otherwise agreed, the following procedure shall be followed for chemical requirements:

From those test pieces which have conformed to physical requirements further test pieces shall be selected at random according to col 4 of Table 6. These samples shall be tested for all the chemical requirements. If a test piece fails to meet the respective chemical requirement, it shall be called a defective. The lot shall be considered to have conformed to the chemical requirements if all the individual test pieces tested for chemical requirements pass the test.

C-4 CRITERIA FOR CONFORMITY

A lot shall be considered to have conformed to the requirements of the specification if C-3.1 and C-3.2 are satisfied.

Table 6 Scale of Sampling and Permissible Number of Defectives

(*Clauses* C-2, C-3.1 *and* C-3.2)

No. of Coils in the Lot	No. of Coils for Physical Requirements	Permissible Number of Defective Coils	No. of Tests for Chemical Requirements
(1)	(2)	(3)	(4)
Up to 25	2	0	1
26 to 50	3	0	1
51 to 150	5	0	2
151 to 300	8	1	2
301 and above	13	1	2

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Amendments Issued Since Publication

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